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AUTHOR Babcock, Judith [illegible].
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ABSTRACT

Indexing is a tool that can be used with longitudinal, quantitative data for analysis of relative changes and for comparisons of changes among items. For greater accuracy, raw financial data should be deflated into constant dollars prior to indexing. This paper demonstrates the procedures for indexing, statistical deflation, and the use of appropriate price indexes for characteristics could account for 8-21 percent of the Education Price Index or its subindexes are recommended and examples provided. Included are illustrations from aggregates of enrollment, income, and expenditures categories of a state's public institutions that compare actual dollar amounts and equivalent constant dollars, as well as indexes of the actual dollar amounts and indexed constant dollars. (Author)

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INDEXING COMBINED WITH STATISTICAL DEFLATION AS A TOOL FOR ANALYSIS OF LONGITUDINAL DATA

Judith A. Babcock
Department of Economics and Management
Rhode Island College
Providence, Rhode Island

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ABSTRACT

Indexing is a tool that can be used with longitudinal, quantitative data for analysis of relative changes and for comparisons of changes among items. For greater accuracy, raw financial data should be deflated into constant dollars prior to indexing. This paper demonstrates the procedures for indexing, statistical deflation, and the use of appropriate price indexes for deflation. For postsecondary institutions, the Higher Education Price Index or its subindexes are recommended and examples provided. Included are illustrations from aggregates of enrollment, income, and expenditures categories of a state's public institutions that compare actual dollar amounts and equivalent constant dollars, as well as indexes of the actual dollar amounts and indexed constant dollars.

INDEXING COMBINED WITH STATISTICAL DEFLATION AS A TOOL FOR ANALYSIS OF LONGITUDINAL DATA

A fairly simple statistical tool for analysis of longitudinal quantitative data is that of indexing. This involves converting raw data to numbers based on 100 that reflect the relative change in a data item over time. While the procedure is not new--we are all familiar with the Consumer Price Index, the Dow-Jones Industrial Average, and various other economic indices--it could be used more frequently by administrators and researchers in higher education, as one tool in analysis for decision making and in evaluations of relevant data.

Indexing has a number of advantages. One is that comparison can be simplified; it is easier to compare relative change to a base of 100 than to an absolute value, such as 1,421 majors and 3,253 majors (Parsons, 1974). Another advantage is that sensitive data, such as financial figures, can be reported publicly without anyone being able to discern the absolute values. Thus, indexing masks absolute values but does not obscure relative changes in magnitude that have occurred. A third advantage is that "apples" and "oranges" can, in a sense, be compared. For example, through index numbers, enrollment can be compared with income or with expenditures, or line item expenditures can be compared among units within an institution or across institutions, or line items within a unit can be compared--for the changes that have occurred.

The use of index numbers, as well as percentage distributions, was recently advocated by Fuller (1982) of the Nebraska Coordinating Commission for Postsecondary Education. He demonstrated this

use with data on enrollments, degrees granted, income, expenditures, and the number of faculty and the average nine-month salary. This paper proposes a refinement to the advocacy of these tools--that of statistical deflation of the raw financial data into constant dollars equivalent to the base year (first year in the data series) prior to indexing. If inflation is not taken into account, the index numbers would distort the actual situation. This paper will demonstrate the procedures for indexing, statistical deflation, and the use of appropriate price indexes--all of which can be done with a hand-held calculator. By way of illustration, raw financial data will be converted into constant dollar figures, and indexes of the raw data compared with those that have been deflated.

THEORETICAL FRAMEWORK

The theoretical framework for this paper is grounded in the statistical procedures of indexing and deflation. Index numbers are actually percentages interpreted in terms of the base time period, with the raw data for the base time period assigned an index number of 100. The raw figure for the next time period is divided by that for the base year and the resulting number multiplied by 100. Thus, the index number (I) = $\frac{T_2}{T_1}$ (100), where T_1 is the data for the first time period and T_2, that for the second time period. The process is repeated for each time period always dividing by the raw figure for the first time period.

When indexing financial data, however, the effects of inflation need to be accounted for or else the index numbers will distort the worth of the relative changes in each time period. For

example, a five percent increase in expenditures turns out to be a real decrease of four percent if prices have increased by nine percent. The solution is to deflate the data into constant dollars, equivalent to the value of the dollars in the base year, before converting the data to index numbers. This is accomplished through the use of an appropriate price index.

METHODOLOGY

The procedure for deflation is expressed by the following formula (Chou, 1969, p. 509):

$$\text{constant dollars} = \frac{\text{current dollars}}{\text{price index}} \quad (100)$$

A number of price indexes are available, but all are not appropriate for every situation. The Consumer Price Index, while widely used, is not appropriate for deflating income and expenditures for postsecondary institutions because it includes items, such as mortgage and food costs, that do not belong in the "market basket of goods and services" purchased by colleges and universities. To be appropriate, a price index should be representative "of all or most of the prices or commodities judged to be important in the population" (Chou, 1969, p. 510) for which the index is being used.

The most appropriate index for data from institutions of postsecondary education is the Higher Education Price Index (HEPI) constructed by Halstead (1977), who updates the index each year. HEPI measures average changes in the prices of a fixed group of goods and services purchased by colleges and universities through current fund educational and general expenditures. This includes expenditures for instruction, departmental research, extension and

public service, educational programs supported by outside sponsors, student services, general administrative expenses, staff benefits, libraries, and the operation and maintenance of the physical plant. It does not include sponsored research and auxiliary enterprises. Halstead also constructed a Research and Development Price Index (R & DPI), which measures average changes in current direct expenditures for sponsored research.

An advantage of using HEPI is that it provides subindexes for various types of expenditures that can then be used alone or in combination. (See Table 1.) For example, instructional expenditures do not include finge benefits and utilities, and the proportion of HEPI that these categories represent can be removed mathematically.

Thus,

$$\text{HEPI less fringe benefits and Utilities (\% Change)} = \text{HEPI (\% Change)} - [.09\ (\text{Fringe Benefits})]_{\%\ \text{Change}} - [.03\ (\text{Utilities})]_{\%\ \text{Change}}$$

The procedure for converting the percentage of change into index numbers is as follows:

$$I_g = \frac{C_g\ I_{g-1}}{100} + I_{g-1}$$

where I_g = Index for given period

I_{g-1} = Index for previous period

C_g = Percent change for given period

In order to obtain the percentage changes from the index numbers in Halstead's tables, select the year desired for a particular component, subtract the previous year's index number from the selected year's index, and divide by the previous year's index. For example, the index for professional salaries in 1980 was 202.1,

and was 188.7 in 1979. Thus, $\frac{202.1 - 188.7}{188.7}$ = 7.1 percent

For the illustrations used in this paper, 1976-77 will be the base year, and the following price indexes will be used: HEPI, R & DPI, HEPI less fringe benefits and utilities, HEPI less utilities, HEPI less fringe benefits, the HEPI faculty salary subindex, and the Consumer Price Index (CPI). Table 2 indicates the index numbers for each of these.

ILLUSTRATION OF PROCEDURES AND RESULTS

Data distributed by Fuller (1982) on Nebraska institutions is used to demonstrate the deflation and indexing procedures, and to make comparisons between indexes using actual dollars and those developed from constant dollars (see Tables, 3, 4, 5, and 6).

As an example, the actual income from tuition and fees for 1977-78 was $66,382 (to the nearest $1,000) as shown on Table 3. That figure is first deflated into constant dollars:

$$\frac{66,382}{106.7} \quad (100) \quad = \quad 62,214$$

The actual dollar index is

$$\frac{66,382}{61,660} \quad (100) \quad = \quad 107.7$$

The constant dollar index is:

$$\frac{62,214}{61,660} \quad = \quad 100.9$$

While there was an increase in actual dollar income in tuition and fees of nearly $5 million, the value of those dollars (in terms of their purchasing power) was only about $550,000--a far cry from $5 million! By the fifth year in the series, the difference between the actual dollar amount and the value of that amount was even greater--on the order of $24 million. It can be concluded that

the value of income from tuition and fees has remained the same throughout these five years.

Each item of income in Table 3 and expenditures in Table 4[1] can be analyzed separately as well as comparatively for a number of conclusions that could lead to decisions, as well. For example, comparisons of income from federal, state, and local sources can be compared.

From Table 5, comparisons can be made among enrollment, income, and expenditure data. This is particularly important with respect to public institutions who depend upon the decisions of legislators for a large proportion of their funding. Over the five-year period, enrollment increased to an index of 114.4. The actual dollar index for income is 146.6, and is 149.5 for expenditures. These figures make it appear that the institutions were flush with funds, i.e., there was a much greater increase in funding than in enrollment. But the constant dollar index shows that this is not so, and that, in fact, funding has not kept up with enrollments, nor have expenditures. (Granted that a number of students can probably be added with no additional resources needed, but over the long term more resources are necessary.)

An additional advantage to indexing with deflated dollars is that expenditures that are not under the control of the institutions (e.g., fringe benefits and utilities) are already taken

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[1]Note that expenditure items are deflated using several price indexes, each determined by an appropriateness criterion.

into consideration. The constant dollar index for operating and plant maintenance expenditures does not show the tremendous rise in those uncontrollable items.

One of the most difficult items for an institution to deal with is that of faculty salaries, a high proportion of its expenditures. Table 6 shows the average nine-month salary of Nebraska faculty members. The constant dollar index using the HEPI Faculty Subindex demonstrates that there was little change in the amount the institutions paid faculty members, and that the amount of change each year was similar to that of other institutions on a national basis. These figures can also be analyzed in terms of what faculty members can buy with their salaries. For this purpose, the CPI is a more appropriate price index to use for deflation. Table 6 illustrates that the average salary declined nearly nine percent in purchasing power over the five years.

CONCLUSION

This paper has demonstrated that deflation of financial figures prior to indexing those figures provides more accuracy for analytical and interpretive purposes. It is particularly important for public institutions so that indexed data are not misinterpreted by those involved in the funding process. Some legislators, on seeing expenditure or income figures much larger than enrollment figures, are likely to conclude that the institutions do not need an increase in funding and that there is a lot of "fat" that could be cut out of the institution's budgets.

Indexing, combined with deflation, can also be a useful tool for internal analyses. For example, are subunits with increased student demand being provided the necessary resources? Are pro-

grams deemed to be of a priority nature being supported adequately? Are increases in funding actual increases, or are they decreases in purchasing power?

Through indexing, comparisons can be made that could not otherwise be made, particularly in terms of the relative changes that occur across time. These comparisons can be evaluated in light of priorities and other relevant factors, and corrective actions can be taken if necessary.

In sum, statistical indexing, combined with deflation, can be a useful tool to both administrators and researchers. It is a simple tool, yet one that can enable analysts to gain insights about the institution.

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Table 1

Weighting of HEPI and R & D Price Index

Category	Percent of Total Expenditures: Educational and General[a]		Sponsored Research	
PERSONNEL COMPENSATION				
1.0 Professional Salaries		58.0		45.7
1.1 Faculty	42.2		17.3	
1.2 Research Associates	0		15.1	
1.3 Graduate Assistants	2.7		10.2	
1.4 Other professional, nondoctoral	0		3.1	
1.5 Extension and public service	2.6		0	
1.6 Administrative and institutional services	8.5		0	
1.7 Library personnel	2.0		0	
2.0 Nonprofessional wages and salaries		15.0		14.3
2.1 Technicians	1.5		7.0	
2.2 Craftsmen	1.0		2.4	
2.3 Clerical	5.4		2.4	
2.4 Students	2.0		2.5	
2.5 Service	4.0		0	
2.6 Operators and Laborers	1.1		0	
3.0 Fringe Benefits		9.0		7.0
CONTRACTED SERVICES, SUPPLIES, AND EQUIPMENT				
4.0 Services		7.3		16.0
4.1 DP and equipment rental	1.4		2.9	
4.2 Communication	1.5		.8	
4.3 Transportation	.7		2.0	
4.4 Printing and duplicating	.5		.8	
4.5 Miscellaneous services	3.2		8.4	
4.6 Consultants and other professionals	0		1.1	
5.0 Supplies and Materials		3.5		7.0
6.0 Equipment		2.5		10.0
7.0 Books and periodicals		1.7		0
8.0 Utilities		3.0		0
Total		100.0		100.0

[a]Excluding expenditures for sponsored research

(Halstead, 1977, pp. 5-6)

TABLE 2

PRICE INDEXES USED

	HEPI	HEPI-(FB&U)	HEPI-FB	HEPI-U	HEPI FACULTY	R&DPI	CPI
1976-77	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1977-78	106.7	105.4	105.8	106.3	105.3	106.5	106.8
1978-79	114.9	111.9	112.7	114.2	111.4	114.8	116.7
1979-80	126.3	120.9	113.8	124.6	119.3	125.1	132.2
1980-81	139.8	131.5	124.7	137.1	129.6	138.5	147.5

TABLE 3

EDUCATIONAL & GENERAL INCOME
INDEXED WITH ACTUAL DOLLARS[a] & CONSTANT DOLLARS[b]

	1976-77	1977-78	1978-79	1979-80	1980-81
Tuition & Fees					
Actual $	61,660	66,382	72,497	80,250	87,792
Constant $	61,660	62,214	63,096	63,539	62,798
Actual $ Index	100.0	107.7	117.6	130.2	142.4
Constant $ Index	100.0	100.9	102.3	103.0	101.8
Fed. Appropriations, Grants, & Contracts					
Actual $	36,371	39,741	38,242	42,450	43,154
Constant $	36,371	37,246	33,283	33,610	30,868
Actual $ Index	100.0	109.3	105.1	116.7	118.7
Constant $ Index	100.0	102.4	91.5	92.4	84.9
State Appropriations, Grants, & Contracts					
Actual $	125,627	134,891	147,071	161,094	176,257
Constant $	125,627	126,421	127,999	127 549	126,078
Actual $ Index	100.0	107.4	117.1	128.2	140.3
Constant $ Index	100.0	100.6	101.9	101.5	100.4
Local Appropriations, Grants & Contracts					
Actual $	11,150	14,294	14,743	16,085	20,380
Constant $	11,150	13,396	12,831	12,736	14,578
Actual $ Index	100.0	128.2	132.2	144.3	182.8
Constant $ Index	100.0	120.1	115.1	114.2	130.7
Private Gifts, Grants, & Contracts					
Actual $	15,048	18,195	21,230	24,580	25,476
Constant $	15,048	17,052	18,477	19,462	18,223
Actual $ Index	100.0	120.9	141.1	163.3	169.3
Constant $ Index	100.0	113.3	122.8	129.3	121.1
Other					
Actual $	18,366	19,741	21,438	33,211	40,214
Constant $	18,366	18,501	18,658	26,295	28,765
Actual $ Index	100.0	107.5	116.7	180.8	219.0
Constant $ Index	100.0	100.7	101.6	143.2	156.6
Total Income					
Actual $	268,222	293,249	315,221	357,670	393,273
Constant $	268,222	274,835	274,344	283,191	281,311
Actual $ Index	100.0	109.3	117.5	133.4	146.6
Constant $ Index	100.0	102.5	102.3	105.6	104.9

[a] nearest $1,000

[b] deflated using HEPI

TABLE 4

EDUCATIONAL & GENERAL EXPENDITURES
INDEXED WITH ACTUAL DOLLARS[a] & CONSTANT DOLLARS

	1976-77	1977-78	1978-79	1979-80	1980-81
Instruction					
Actual $	112,576	120,678	135,278	149,182	162,471
Constant $[b]	112,576	114,495	120,892	123,393	123,552
Actual $ Index	100.0	107.2	120.2	132.5	144.3
Constant $ Index	100.0	101.7	107.4	109.6	109.7
Research					
Actual $	25,685	28,470	29,685	34,360	38,769
Constant $[c]	25,685	26,732	25,858	27,466	27,992
Actual $ Index	100.0	110.8	115.6	133.8	150.9
Constant $ Index	100.0	103.4	100.7	106.9	109.0
Public Service					
Actual $	19,790	21,622	22,005	23,989	27,130
Constant $[b]	19,790	20,514	19,665	19,842	20,631
Actual $ Index	100.0	109.3	111.2	121.2	137.1
Constant $ Index	100.0	103.7	99.4	100.2	104.2
Academic Support					
Actual $	19,754	23,319	25,562	28,820	32,167
Constant $[b]	19,754	22,124	22,933	23,838	24,462
Actual $ Index	100.0	118.1	129.9	145.9	162.8
Constant $ Index	100.0	112.0	116.1	120.7	123.8
Student Services					
Actual $	10,544	12,220	13,092	14,769	15,828
Constant $[b]	10,544	11,594	11,700	12,216	12,037
Actual $ Index	100.0	115.9	124.2	140.1	150.1
Constant $ Index	100.0	110.0	111.0	115.9	114.2
Institutional Support					
Actual $	23,437	29,086	32,087	34,563	39,238
Constant $[b]	23,437	27,596	28,675	28,588	29,839
Actual $ Index	100.0	124.1	136.9	147.5	167.4
Constant $ Index	100.0	117.7	122.3	122.0	127.3
Oper. & Plant Maint.					
Actual $	24,632	27,416	31,035	33,453	36,129
Constant $[d]	24,632	24,285	27,538	29,396	28,973
Actual $ Index	100.0	111.3	126.0	135.8	146.7
Constant $ Index	100.0	98.6	111.8	119.3	117.6
Other					
Actual $	18,366	19,746	21,438	33,211	40,214
Constant $[e]	18,366	18,564	18,772	26,654	29,332
Actual $ Index	100.0	107.5	116.7	180.8	219.0
Constant $ Index	100.0	101.1	102.2	145.1	159.7

continued on next page

	1976-77	1977-78	1978-79	1979-80	1980-81
Total Expenditures					
Actual $	248,136	276,095	301,819	334,704	370,884
Constant $[f]	248,136	258,758	262,680	265,007	265,296
Actual $ Index	100.0	111.3	121.6	134.9	149.5
Constant $ Index	100.0	104.3	105.9	106.8	106.9

[a] nearest $1,000

[b] using HEPI minus fringe benefits and utilities

[c] using R & D price index of HEPI

[d] using HEPI - Fringe Benefits

[e] using HEPI-Utilities

[f] using HEPI

TABLE 5

COMPARISONS OF ENROLLMENT, INCOME, & EXPENDITURES
USING ACTUAL $ AND CONSTANT $ INDICES

	1976-77	1977-78	1978-79	1979-80	1980-81
Enrollment					
Undergraduate	100.0	100.2	106.4	110.8	115.3
Graduate	100.0	100.6	99.6	107.4	108.7
1st Professional	100.0	107.7	106.4	105.3	108.0
Total	100.0	100.4	105.8	110.3	114.4
Total Income					
Actual $ Index	100.0	109.3	117.5	133.4	146.6
Constant $ Index	100.0	102.5	102.3	105.6	104.9
Total Expenditures					
Actual $ Index	100.0	111.3	121.6	134.9	149.5
Constant $ Index	100.0	104.3	105.9	106.8	106.9

TABLE 6

AVERAGE NINE-MONTH SALARY,
FULL-TIME INSTRUCTIONAL FACULTY,
INDEXED WITH ACTUAL DOLLARS & CONSTANT DOLLARS

	1976-77	1977-78	1978-79	1979-80	1980-81
Actual $	16,636	17,663	18,712	20,044	22,498
Constant $[a]	16,636	16,774	16,797	16,801	17,360
Constant $[b]	16,636	16,538	16,034	15,162	15,253
Actual $ Index	100.0	106.2	112.5	120.5	135.2
Constant $ (HEPI) Index	100.0	100.8	101.0	101.0	104.4
Constant $ (CPI) Index	100.0	99.4	96.4	91.1	91.7

[a] using HEPI Faculty Salary Subindex

[b] using Consumer Price Index